



## TITLE OF THE INVENTION

Woven Fabric of Noble Metal Filament, and an Apparatus and Method  
of Manufacturing the Same

## FIELD OF THE INVENTION

The present invention relates to woven fabrics of noble metal filament and a method of manufacturing the same, and more particularly, it relates to cloth, textile, and drapery for apparel design that are woven from gold monofilaments.

## PRIOR ART

In the state of the art, fabrics woven from noble metal in use for apparel and garniture designs have been fabricated by winding foils of noble metal around threads of silk, cotton, or synthetic and then weave the resultant yarns into cloth. In contrast, fabric woven from monofilaments of noble metal, especially fabric woven from monofilaments of fine gold semi-permanently retains its original luster and beauty, and because of a supposed value when used for garniture, attempts to fabricate such fabric have been made for a long time. However, fine monofilament of noble metal, particularly gold monofilament is fragile and severs so easily, and therefore, it is hard to weave such fine monofilaments into thin elastic cloth. Throughout the present disclosure, the term "noble metal" will be referred to generally as metals such as gold, silver, platinum, iridium, and various alloys containing them in combination.

Cloth products using metal monofilaments include mesh of noble metal in medical use. However, such mesh is coarse, stiff, and insufficient in elasticity, and should have rather been properly classified in a group of metal net.

Japanese Patent Publication No. S54-43636 discloses a method of manufacturing knitted fabrics of metal filament. In this method, a large number (150) of stainless steel strings are passed through a copper tube, and all of them are together subjected to die-drawing and heating procedures repetitively to fabricate finer composite wire. Then, after strings of the composite wire are woven into cloth, the cloth is chemically treated to fuse off the outermost copper tube alone so as to obtain woven fabric of very fine stainless steel filaments. The resultant fabric is elastic but of full volume by virtue of the weave material of bundles of numerous very fine filaments, or, in other words, cloth of a certain thickness is produced. In the above-identified disclosure, additionally, there is no reference to an altered method of manufacturing woven fabrics of noble metal such as gold.

Accordingly, it is an object of the present invention to produce thin elastic woven fabrics of noble metal monofilaments that have never been attained in the prior art and that are suitable in use for apparel and garniture designs. According to the present invention, woven fabrics of noble metal filaments can be obtained, which semi-permanently retain their original luster and beauty and are valuable when used in garniture design. Also, the woven fabrics according to the present invention, when woven from warp and weft of noble metal monofilaments, can have noble metal alone collected easily therefrom and recycled, and thus, the fabrics will not lose their excellence in view of property value as jewelry metal.

#### SUMMARY OF THE INVENTION

The present invention is directed to fabric woven from noble metal filament which is 0.12 to 6.5 N in tensile strength, and at least either of weft and warp is of noble metal monofilament having such a property. Preferably, the noble metal monofilament of 1.5 % or above in elongation percentage is used.

Additionally, it is preferable that 14-carat gold, 18-carat gold, 24-carat gold, or gold alloy is used for the noble metal monofilament.

In another aspect of the present invention, a method of manufacturing woven fabric from noble metal filament includes the steps of setting up warp through two preparation stages of warping and adjusting loom mechanism, setting up weft of noble metal monofilament by using a filling winder to wind the weft on a bobbin, and weaving the warp and weft into fabric at a shuttle loom, and in the step of using a filling winder to wind the weft on a bobbin, a rotation velocity at which the weft is wound on the bobbin is continuously altered.

In still another aspect of the present invention, an apparatus of manufacturing woven fabric of noble metal filament comprises a warper for setting up warp, a filling winder for winding weft of noble metal monofilament on a bobbin to set up the weft, and a shuttle loom at which the weft and warp set up in the previous steps are woven, and the filling winder has a speed-varying means to continuously alter a rotation velocity at which the weft is wound on the bobbin. Preferably, the speed-varying means may be an inverter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be best understood in conjunction with the accompanying drawings through which like reference numerals generally denote the equivalent or similar elements:

Fig. 1 is a block diagram showing procedural steps of manufacturing woven fabric;

Fig. 2 is a schematic perspective view showing a shuttle loom;

Fig. 3 is a schematic diagram showing a filling winder; and

Fig. 4 is a schematic diagram showing a shuttle with a bobbin being attached thereto.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings. Fig. 1 is a diagram illustrating procedural steps of manufacturing woven fabric while Fig. 2 is a schematic perspective view showing a shuttle loom. For the purpose of creating woven fabric, warp and weft must be properly adjusted in advance of a looming operation. Specifically, in a step S1 of warping, strings of warp 12 cut in required lengths are wound on a warp beam 22 by a warper (not shown). After that, in a step S2 of preliminary looming, the strings of warp 12 are set up, extending via a roller 24 and a lease rod 26 to pass through harnesses 30a and 30b, respectively. The strings of the warp 12 extending out of the harnesses 30a and 30b are further passed through a reed 34 and wound on a take-up roll 28. Although, in this embodiment, two pieces of harnesses are used, alternatively more than two pieces of them may be used. Also, in this embodiment, the warp 12 is of gold monofilament having suitable diameter, tensile strength, and elongation percentage. Such suitable monofilament will be described in detail later.

Next, set-up of weft 14 will be described. In a step S3 of winding weft on a bobbin, the weft 14 of fabric component is unwind from a large reel and then rewound on a small bobbin with which a shuttle is to be loaded. A filling winder 50 that functions to take the weft from the reel to wind it on the bobbin is schematically illustrated in Fig. 3. The filling winder 50 is provided with a mount 55 loaded with a reel 60, a ring 56 and pulley 58 guiding a string of yarn, a motor 52 that drives a bobbin 42 to get the string of yarn wound thereon, an inverter 53 altering a rotation velocity of the motor, and a controller 54 controlling the rotation velocity.

The weft 14 of gold monofilament used in this embodiment is supplied

by the large reel 60, and the monofilament wound on the reel 60 is passed through the ring 56 and the pulley 58 and then taken up on the bobbin 42 that is to be attached to the shuttle. The bobbin 42 is rotated by the motor 52, and at this time, since the monofilament of noble metal as used in the present invention is usually poor in tensile strength, the monofilament may be severed because of actuation of the motor 52 as rapid as in an event of winding silk or cotton yarn on a bobbin. Thus, according to the present invention, the motor 52 is driven with a speed varying means such as the inverter 53 to continuously accelerate the motor 52. Additionally, when the bobbin 42 is stopped at the end of the take-up, the motor 52 is gradually decelerated so as not to apply strong force to the monofilament. In order to control acceleration/deceleration of the motor 52, the controller 54 is attached to the inverter 53. However, a rotation rate of the motor 52 may be manually controlled without attachment of the controller 54.

The bobbin 42 having the weft rewound thereon is mounted in the shuttle 32 in a step S4. A schematic diagram of the shuttle 32 is in Fig. 4. The shuttle 32 has a frame 40 having a bearing, a shaft 44 held by the bearing, the bobbin 42 that has the shaft 44 extending therethrough, metal fittings 45 fixed to the frame 40, a ring 45a fitted on the metal fittings 45, and two springs 48 attached to the frame 40. The weft 14 wound on the bobbin 42 is threaded over the frame 40 through the ring 45a and passed through a ring at an end of one of the springs 48 and then through a ring at an end of the other of the springs 48, and eventually the weft further extends externally through an eye provided in the metal fittings 45.

When ordinary yarn such as silk or cotton yarn is used for the weft and warp woven into cloth, the bobbin 42 rotates and unreels the weft 14 while the shuttle 32 reciprocally moves through the strings of the warp 12. Instead, when the weft 14 is replaced with monofilament of noble metal, the bobbin 42

having its rotation suppressed causes the weft 14 to sever. This is because a large relative density of the noble metal monofilament wound on the bobbin 42 results in the bobbin being over-weighted to lead to an increase in frictional resistance between the shaft 44 and the bobbin 42. Thus, in the present 5 invention, a ball bearing 46 is attached to opposite ends of the bobbin 42 to reduce the frictional resistance applied to the bobbin 42. In this way, even with monofilament fragile to easily cut off, severance of such monofilament can be prevented.

After the completion of the adjustment of the warp 12 and weft 14, they are woven in cloth in a step S5 of looming. First, after the shuttle 32 is passed through the strings of the warp 12, the reed 34 is actuated to move forward and beat the weft 14 toward the front of the loom. Then, the harness 30a is lowered while the harness 30b is raised, so as to clear a shed, and the shuttle 32 is made run through it. Succeedingly, the reed 34 is moved to beat the weft 14 forward. This procedure is repeated to create woven fabric.

Depending upon a configuration of the loom 10, only one of the harnesses may be raised (upper-opening cleared) or lowered (lower-opening cleared) to clear the shed. Although, in this embodiment, two pieces of the harnesses 30a and 30b are used, more than two pieces of the harnesses may be 20 used to create more complicated patterns of weaving.

After the completion of the step S5 of looming, the resultant fabric is subjected to an examination to finish the looming procedure in a step S6 of examining woven fabric. In this case, the shuttle loom has been used and explained, but any of shuttle-free looms may be substituted.

25 The noble metal monofilament used for the woven fabric will now be described. Very fine monofilament of noble metal is generally fragile, compared with silk yarn and cotton yarn, and such monofilament, when woven at a loom, causes some difficulty in the course of the looming. Since, in general,

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an increase in a diameter of the monofilament leads to an enhancement of tensile strength of the monofilament, the monofilament does not sever so often during weaving the fabric, but when the monofilament is excessively increased in diameter, the resultant woven fabric lacks elasticity to such an extent that it can no longer be suitable for cloth and drapery. As a result of testing monofilaments of various materials and various noble metals according to the woven-fabric manufacturing procedure of the present invention as described above, fabric woven from noble metal monofilament is innovatively manufactured, successfully attaining a property of satisfactory elasticity in use for cloth and drapery. In this way, such sufficient elasticity in the woven fabric made of noble metal filament according to the present invention permits the woven fabric to be sewn at a sewing machine similar to conventional silk and cotton woven fabrics, and allows it to be used for materials of apparel design just like ordinary cloth and textile.

As the metal monofilament used for the woven fabric increases in diameter, and as it increases in tensile strength, the monofilament during the looming procedure becomes less breakable, but an excessive increase in diameter and tensile strength causes the resultant woven fabric to be too inelastic to use like cloth and drapery. The monofilament of an altered material is, even having the same diameter, insufficient in tensile strength to cause severance during the looming procedure, or reversely excessive in tensile strength to result in the woven fabric being inelastic. Even if the monofilament of an altered material is equivalent in diameter and tensile strength, such monofilament having a small elongation percentage at an instance of the severance due to tensile force has a reduced toughness, which may lead to the severance of the monofilament during the looming operation.

As a result of repetitive tests on trial products according to the present invention, it was observed that only when the monofilament was 0.12 to 6.5

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Newton (N) in tensile strength, or preferably, 0.20 to 2.0 N, and was 1.5 % or above in elongation percentage at the instance of the severance of the monofilament due to the tensile force, or preferably, 2.0 % or above, such monofilament could be woven in fully stable condition into fabric in the manner  
5 as mentioned above, and the resultant product of woven fabric could be fully elastic to be suitable in use for cloth and drapery. Desirable examples of the monofilament meeting the above conditions include monofilament of 24-carat gold which is approximately 30 to 200 micrometers (.) in diameter, preferably, 40 to 60 micrometers, and monofilaments of various alloys containing noble metals, which are approximately 14 to 100 micrometers in diameter.

#### EMBODIMENTS

Embodiments of the present invention will now be described. Noble metal monofilaments that will be described below include monofilament of gold (24-carat gold) and monofilaments of gold alloys comprised of 99.7 % fine gold and a trace of an element such as Gd (gadolinium), Ca (calcium) and the like, which are disclosed in International Patent Publication No. PCT/JP96/00510 (referred to simply as gold alloy herein). The monofilaments tested have diameters of 30, 50, 70 and 100 micrometers, for example. For the purpose of  
20 comparison, 24-carat gold monofilament of 20 micrometers in diameter is also added to the samples to weave into fabric. Features of each sample filament are listed in Table 1.

TABLE 1

	Diameter of Monofilament (.)	Material	Tensile Strength (N)	Elongation Percentage
Embodiment 1	30	24-Carat Gold	0.141	6.4
Embodiment 2	50	24-Carat Gold	0.410	6.9
Embodiment 3	70	24-Carat Gold	0.544	15.2
Embodiment 4	30	Gold Alloy	0.884	2.0
Embodiment 5	50	Gold Alloy	1.51	2.0
Embodiment 6	70	Gold Alloy	3.16	1.9
Embodiment 7	100	Gold Alloy	6.04	2.0
Comparison 1	20	24-Carat Gold	0.084	1.3

The tensile strength and elongation percentage of each monofilament was measured by using a constant-speed elongation tester well known in the art. The monofilament was grasped at two points with an interval of 10 cm therebetween and was drawn in opposite directions at a drawing speed of 10 cm/min, and a tensile load at an instance of severance of the monofilament was regarded as the tensile strength while a ratio of elongation of the monofilament was defined as the elongation percentage.

In each of the embodiments and comparison example as listed above, both the warp 12 and the weft 14 woven into cloth are monofilaments of the same properties. However, the warp 12 and the weft 14 may be monofilaments different from each other in material and/or diameter, and alternatively, the warp 12 and the weft 14 may be monofilaments other than noble metal monofilaments. Any of these variable conditions could be applied to the

monofilaments of Embodiments 1 to 7 listed in Table 1 to weave them into fabric. On the contrary, the monofilament shown in Comparison 1 severed easily in the step S3 of winding the weft on the bobbin, and also severed so frequently in the step S5 of looming, and the monofilament could not provide a 5 sufficiently stable condition of looming in practical use. As to the monofilament of Embodiment 1, it could be woven into fabric in a fully stable condition, but in the step S3 of winding weft on a bobbin, an operator must be fastidious about adjustment of a velocity at which the weft was wound on the bobbin. Further, as for the monofilament of Embodiment 6, the monofilament sometimes fractured despite its considerably large diameter, in the step S5 of looming. The reason of this was concluded that the elongation percentage of the monofilament was relatively small.

The finished woven fabrics from all filaments of Embodiments 1 to 7 had satisfactorily elastic and flexible to be suitable in use for clothes and draperies except that, in comparison, the monofilament of Embodiment 7 was relatively poor in elasticity to such an extent that an application range of the resultant fabric should be slightly restricted.

The present invention can provide thin elastic woven fabric of noble metal monofilament, which is impossible to fabricate in the prior art and which 20 is suitable in use for apparel and garniture designs.

Although the preferred embodiments of the present invention and their respective variations have been described, people having ordinary skills in the art would envision various modifications of those embodiments. Accordingly, 25 the present invention should not be limited to precise forms and manners in the above disclosure and description but should simply be taken by way of examples. Thus, the present invention can be varied and modified without departing the true scope and spirit thereof as defined in the appended claims.